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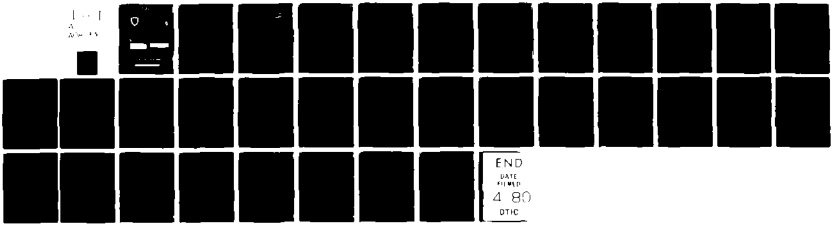

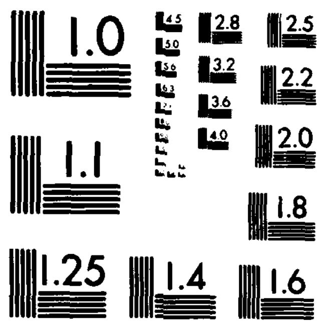

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ILIR INVESTIGATION

PARTIAL REPORT

COMPATIBILITY OF SILICONE-BASED BRAKE FLUIDS WITH ELASTOMERIC COMPONENTS OF ARMY VEHICLES AND WEAPON SYSTEMS

PHASE I

FEBRUARY 1980

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Brake fluid	Immersion tests
Silicone	Swelling
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Elastomers	Disintegration

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

An investigation was conducted to determine the compatibility of recently specified silicone brake fluids with elastomers expected to be found in developmental vehicles submitted to US Army Aberdeen Proving Ground for tests and to compare their performance with conventional fluids. More than 1200 immersion tests were conducted at temperatures ranging from 0° F to 248° F (-18 to +120° C) with 14 different elastomers and 5 different brake fluids. It was found that the silicone brake fluids performed as well as/or

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20. better than the conventional fluid in all tests involving vehicle brake system elastomers. Extended periods of exposure did not reveal any deficiencies. Studies are continuing on mixtures of silicone and conventional fluids in order to accumulate data which will aid in identifying and evaluating possible problems found in test vehicles.

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FOREWORD

This work was accomplished under the Army's In-House Laboratory Independent Research (ILIR) Program, TECOM Project No. 7-CO-IL8-AP1-001, Task 02.

Acknowledgment is extended to PFC Linda Brogan and Sp 4 Linda Maillet for their assistance in the accumulation of laboratory data included in this report and to Mr. M. Drabo for his guidance in the performance of the investigation and editorial assistance in presentation of the results.

SECTION 1. SUMMARY

1.1 BACKGROUND

In 1967, because of the success of silicone fluids in other hydraulic systems, producers of silicones became interested in developing silicone based fluids for use in vehicle brake systems. It was recognized that silicone fluids possessed physical and chemical properties that were desirable for this application. Some of these were low-temperature viscosity, high-boiling point, low-water sensitivity, and good chemical stability. Preliminary laboratory studies showed that the first silicone experimental brake fluids performed well except in the areas of lubricity and rubber compatibility. Each of the three major silicone fluid manufacturers centered their brake fluid research around the development of additives to improve these two properties. Subsequent fluids were developed by each of the three manufacturers which performed satisfactorily in laboratory tests. The US Army Coating and Chemical Laboratory located at Aberdeen Proving Ground, Maryland set up a series of field tests in vehicles operating in (1) the tropical rain forest (Panama) (2) the desert (Yuma Proving Ground, Arizona) and (3) The arctic (Fort Greeley, Alaska). Results reported in 1975 (reference 2) and 1976 (reference 3) indicated that the silicone brake fluids were far superior to the conventional polyglycol brake fluids in the areas of low hygroscopicity and corrosion protection. Lubricity and rubber compatibility were equal to or superior to that found with conventional brake fluids.

As a result of these findings a specification, MIL-B-46176, Brake Fluid, Silicone, Automotive, All Weather, Operational and Preservative, was published (reference 4). This specification is expected to supercede the three brake fluid specifications which existed until the present time (references 5, 6 and 7) at a date to be established by US Army Tank-Automotive Research and Development Command, Warren, MI. It is anticipated that production and developmental vehicles submitted to Aberdeen Proving Ground in the future will utilize silicone brake fluids.

The Society of Automotive Engineers (SAE), automotive manufacturers, military vehicle developers, and test engineers have been concerned about the compatibility of the silicone brake fluid with the elastomers which are found in various vehicle systems. In order to resolve these concerns and to corroborate the validity of the basic laboratory and field test data, more discriminating tests were deemed advisable. An in-depth study of fluid-elastomer behavior was needed, which would point out shortcomings such as excessive and uneven swelling, possible leaching of elastomeric ingredients, and minor degradation of specific types of elastomers under unusual or unforeseen operational situations.

Findings from this study could be applied to the analysis of failures occurring in future vehicle tests, and aid brake system design engineers and brake fluid researchers in their evaluation of the performance of the new silicone brake fluids.

1.2 OBJECTIVES

a. To identify possible problem areas involving compatibility of silicone fluids with the many elastomers which are found in military vehicular and weapons systems.

b. To develop more discriminating test procedures pertinent to the resolution of fluid/elastomer compatibility problems, which will aid test engineers in their evaluation of the performance of systems containing silicone fluids.

1.3 SUMMARY OF INVESTIGATION

More than 1200 comparative immersion tests were conducted at temperatures ranging from 0° F to 248° F (-18 to +120° C) with 14 different elastomers and 5 different brake fluids. The silicone brake fluid performed as well as or better than the conventional fluid in all tests involving vehicle brake systems elastomers. No discrepancies were revealed in extended exposure periods.

1.4 CONCLUSIONS

a. It is concluded that: The replacement of the three conventional brake fluids in military vehicles with silicone brake fluids will not adversely affect the brake performance from the standpoint of fluid/elastomer compatibility (para 2.1, 2.2, and 2.3).

b. Mixtures of silicone fluids and conventional fluids could lead to conditions which would affect brake performance due to differences in swelling characteristics of the fluids (para 2.2d and 2.2g). The differences in swelling characteristics which were found were not extreme and would not cause catastrophic brake failure.

c. Depending upon the contaminant, inadvertent addition of engine oils, hydraulic fluids, shock absorber fluids, etc., will cause undesirable attack on brake systems elastomers, which will lead to brake failures (para 2.2f).

1.5 RECOMMENDATIONS

It is recommended that:

a. Every effort be made to discourage and preclude the mixing of silicone fluids and conventional fluids in vehicle brake systems. Users should be cautioned against mixing the fluids, and procedures should be published which require the complete removal of all conventional fluids from the brake system before a silicone fluid is added. It is also recommended that this investigation be continued in the area of the effect that mixing different percentages of fluids would have on brake system elastomers.

b. Silicone fluid manufacturers investigate the use of rubber swelling additives in the silicone fluids which are not miscible with the conventional fluids, and therefore would not migrate into the conventional fluid.

SECTION 2. DETAILS OF INVESTIGATION

2.1 MATERIALS TESTED

The combatibility of representative silicone brake fluids with the elastomeric materials expected to be used in future military vehicles was determined through a series of immersion tests. The following fluid/elastomer combinations were used to evaluate the compatibility:

a. Fluids. The five brake fluids listed the table 2-1 were evaluated.

TABLE 2-1. FLUIDS

Fluids	Type
Code A	Silicone
Code B	Silicone
Code C	Silicone
SAE RM 70	Silicone
SAE RM 66-03	Conventional polyglycol

b. Elastomers. Fourteen elastomers were used in the study, representing all elastomers found in current automotive systems. The elastomers are listed in table 2-2.

TABLE 2-2. ELASTOMERS

Type	Use	Shore A Durometer Hardness
SBR (styrene butadiene rubber)	Wheel cylinder cups	50
SBR	Master cylinder seals	70
SBR (SAE)	Disc brake seals	70
EPDM (ethylene propylene rubber)	Disc brake seals	70
EPDM	Brake valve parts and seals	80
EPDM (SAE, RM 69)	Referee test slabs	70
VITON	O-rings	70

TABLE 2-2. (CONT'D)

Type	Use	Shore A Durometer Hardness
Silicone rubber	Seals and O-rings	60
N. R. (natural rubber) based on SAE-ISO-1	Referee test slab	60
BUNA-N (33% ACN) (nitrile rubber)	Automotive parts	60
BUNA-N (21% ACN)	Automotive parts	70
BUNA-N (41% ACN)	Automotive parts	70
Neoprene (SAE, RM 68)	Brake hose	70-80
Chlorobutyl	Master cylinder diaphragms	60

2.2 IMMERSION TESTS

Nine series of immersion tests have been conducted to date. One-inch slabs of each of the elastomers were washed with isopropyl alcohol, weighed in air and water, hardness determined using a Shore "D" durometer, and immersed in each of the fluids (in duplicate) under the following conditions:

a. Test No. 1. This test was conducted at ambient conditions. Test jars were stored on the laboratory shelf. Rubber specimens were removed after 1 week, 3 weeks, 2 months, 6 months, and 12 months; the specimens were wiped with a clean lint-free cloth, weighed in air and water to determine change in volume, and the hardness was measured. After each storage period the specimens were examined for evidence of disintegration and then placed back in the test jar.

b. Test No. 2. This test was conducted at 70° C (158° F). Rubber specimens were removed after 3 days and 7 days. Test jars were removed from the oven and allowed to cool for 30 minutes. The rubber specimens were then removed, wiped with a clean cloth, weighed in air and water to determine volume, and the hardness was determined; the specimens were examined for disintegration, and after the three day inspection placed back in the test jar; jars were placed back in the oven; after the 7-day inspection the fluids were visually examined for excessive sediment buildup.

c. Test No. 3. This test was identical to Test No. 2 (para 2.2b) except that the test temperature was 120° C (248° F). Rubber specimens were examined after 3 days and 7 days.

2.2 (Cont'd)

d. Test No. 4. In this test each of the silicone fluids was mixed with an equal quantity of the conventional fluid and placed in the test jars. The two fluids were not miscible so they separated. The volume and hardness of two rubber test specimens was determined. One specimen was placed in the lower fluid layer (conventional fluid), and one specimen was suspended horizontally in the top fluid layer (silicone). The jar was stored on the laboratory shelf at ambient temperature. The volume and hardness of each of the two rubber test specimens was measured and examined after 2 weeks, 8 weeks, and 6 months and placed back in the test jars.

e. Test No. 5. This test was conducted at -18° C (0° F). Test jars were removed from the cold chamber after 2 weeks, 8 weeks and 6 months. The volume and hardness of rubber specimens was measured within 10 minutes after the jars were taken from the chamber, after which the specimens were examined for evidence of disintegration and then placed back in the test jars. Exposure to cold temperature continued.

f. Tests No. 6, 6A, 7, 7A and 8. These tests were run on the silicone compatibility fluid and the conventional fluid in order to determine the effect of some common automotive contaminants on the performance of the rubber. In tests No. 6 and 6A, 1% and 5% respectively, by volume of petroleum oil conforming to grade 10, MIL-L-2104 (reference 8) was added to each of the jars. In tests 7 and 7A, 1% and 5% respectively, of synthetic lubricant meeting MIL-L-46167 (reference 9) was added to each of the jars. Each of these tests was stored at ambient temperature and examined after 1 week, 3 weeks and 7 weeks of storage.

g. Test No. 9. In this test, conventional fluid was mixed with the silicone compatibility fluid to produce conventional fluid concentrations of 5%, 10%, 20% and 30% by volume. Rubber specimens were immersed as described in test No. 4 (para 2.2d). Four and eight weeks examinations were made and the test is continuing. Another examination will be made after 26 weeks.

h. Comparison criteria. The criteria listed in table 2-3 were established in reference (4) to check performance of silicone brake fluids on some elastomers found in vehicle brake systems. These criteria were used as a basis for comparing the performance of the fluid/elastomer combinations in these tests with known satisfactory performance levels.

TABLE 2-3. CRITERIA FOR RUBBER PERFORMANCE (REFERENCE 4)

Type of Rubber	Immersion Tests: Volume Swell (percent)	Changes In Hardness (Durometer points)	Test ^{o}C	Temp ^{o}F
SBR	+5 to +20	0 to -10	70 ± 2	158 ± 3
	+5 to +20	0 to -15	120 ± 2	248 ± 3
Neoprene	-3 to + 6	+3 to -10	70 ± 2	158 ± 3
	-3 to +10	+3 to -10	100 ± 2	212 ± 3
EP	0 to +16	0 to -10	70 ± 2	158 ± 3
Natural	+5 to +20	0 to -10	70 ± 2	158 ± 3

2.3 RESULTS AND ANALYSIS

a. Results. Results of all tests are tabulated in appendix A. The data are also available in graphical form at Aberdeen Proving Ground, MD (STEAP-MT-G).

b. Effect on SBR.

(1) Results. Swelling and softening exhibited by all proprietary silicone fluids on SBR fell in the middle range of reference criteria in all tests. Swelling values for the silicone compatibility fluid were borderline high at 0° F and 248° F (-18 and +120° C). Swelling values received with the conventional fluid were low and in some instances at ambient temperature, slight shrinkage occurred.

(2) Analysis. SBR is the most widely used elastomer in drum and shoe brake systems, so the silicone fluid manufacturers adjust the effect-on-rubber properties of the fluids so that the effect on SBR falls in the middle range of reference criteria. The borderline high values received with the silicone compatibility fluid would not cause brake failure. The low swelling values received with the conventional fluid could indicate poor performance because of potential leakage of brake fluid past the cups. In actual vehicle operation no widespread problem has been reported.

c. Effect on neoprene rubber.

(1) Results. Results of tests on neoprene rubber showed that the proprietary silicone fluids gave no excessive shrinkage or swelling regardless of the test temperature. The silicone compatibility fluid gave high swelling values at ambient temperature and 248° F (120° C) after extended exposure. The conventional fluid also gave high values at 248° F.

2.3 (Cont'd)

(2) Analysis. Neoprene rubber is used in brake hoses so the swelling/softening values are not as critical as those for rubber found in components which move during braking applications. Specifications and reference criteria allow slight shrinkage and moderate swelling. The high values recorded in this series of tests for the silicone compatibility fluid and the conventional fluid at 248° F is beyond the normal test temperatures and exposure temperatures for neoprene rubber.

d. Effect on EP rubber.

(1) Results. All silicone fluids performed satisfactorily on EP rubber at all test temperatures. Swelling of the EP rubber with conventional fluid was low; slight shrinkage occurred at 0° F (-18° C).

(2) Analysis. EP rubber polymers are used in disc brake seals, brake valve parts and in some master cylinder applications. The results received in this test with the silicone fluids were excellent and would indicate that no problems would be expected in the use of silicone brake fluids with EP rubber. The amount of shrinkage found with the conventional fluid at low temperatures would not be expected to cause poor performance. Recent research has been directed toward improving the cold-temperature properties of EP rubber.

e. Effect on natural rubber.

(1) Results. Results of all tests on natural rubber/silicone fluid combinations paralleled results found in the SBR tests (para 2.3b). Swelling and softening values for natural rubber fell within the middle range of reference criteria with all proprietary silicones. The values for the silicone compatibility fluid were borderline high at 248° F. The results of the conventional fluid/natural rubber tests were satisfactory at all temperatures.

(2) Analysis. Natural rubber is used in the brake system of some foreign vehicles, but domestic use has diminished over the last decade. The switch to SBR was made because of better availability and increased high-temperature properties. No problem would be expected in systems using natural rubber and silicone fluids.

f. Effect on butyl rubber.

(1) Results. Swelling and shrinkage of butyl rubber was very low in all tests conducted in this program. There was little effect on the elastomer by either the silicone fluids or the conventional fluid.

(2) Analysis. Butyl rubber is used in master cylinder diaphragms and is subjected to static situations only. The results received in this program indicate that there would be no operational difficulties in the use of butyl rubber in the desired application.

2.3 (Cont'd)

g. Effect on nitrile rubber.

(1) Results. In this investigation, except in isolated instances, the silicone fluids were compatible with the three nitrile rubber formulae. The conventional brake fluid is not compatible with nitrile rubber and caused excessive swelling, softening and some rubber disintegration in most tests, especially those tests conducted at high temperatures.

(2) Analysis. Nitrile rubber (Buna N) is compatible with petroleum base fluids and is used extensively in O rings in all systems, such as weapons recoil systems, which use petroleum base hydraulic fluids. It is also used in various automotive applications such as shock absorbers and fuel systems, but is not used in conventional braking systems; it is incompatible with conventional brake fluids. For the purpose of this study the observed compatibility of silicone brake fluids with nitrile rubber is coincidental, but the data derived in the study would be of interest to engineers in the weapons recoil systems field or other fields which at the present time use petroleum base, synthetic base, or other inflammable hydraulic fluids in the systems. Possible advances could be made in the use of silicone fluids in these applications.

h. Mixed fluids.

(1) Results. In tests involving 50/50 mixtures of silicone brake fluid and conventional brake fluid many instances were noted where different amounts of swelling of the rubber test slabs occurred in the two fluids in the same test jar. The swelling which was found was of different magnitude in each layer of fluid and did not match the swelling which occurred when that fluid was tested alone. The differences in swelling were relatively small and showed up gradually over a long period of time. In some cases slight shrinkage occurred in one layer and not in the other layer.

(2) Analysis. The silicone and conventional brake fluids are not miscible. Each fluid contains additives which are placed in the fluid to adjust the rubber swelling and softening to the desired range. When the fluids are mixed, this series of tests showed that one of the fluids extracted the rubber swelling additives from the other fluid and in many instances gave results which showed that the additive had migrated. If the fluids were mixed in a brake system and uneven swelling of the elastomer occured, the distortion of the brake cup could lead to brake malfunction. In cases where shrinkage of the elastomer occurred, fluid leakage would show up in actual operation. The amount of distortion indicated by this study was not extreme, and the resultant effect of the distortion would be gradual and not catastrophic. Tests involving several different silicone/conventional fluid ratios are continuing.

2.3 (Cont'd)

i. Effect of contaminants.

(1) Results. The tests in which engine oil and hydraulic fluids were added to the silicone brake fluids as contaminants showed increased swelling of EP, SBR, NR and silicone rubber; neoprene and Viton shrunk; the nitriles and butyl rubber remained approximately the same. In the contaminated conventional fluid EP, SBR, NR and butyl rubber showed increased swelling; neoprene, nitrile, silicone and Viton remained unchanged. In tests in which the shock absorber fluid was used as the contaminant most of the results were similar to the tests where engine oil or hydraulic fluid were added. Some variations occurred; the neoprene rubber swelled more in both the conventional and silicone brake fluids; the silicone rubber swelled slightly more in the conventional fluid; the butyl rubber shrunk slightly in the silicone fluid.

(2) Analysis. Contaminants were chosen which are most apt to be inadvertently added to the brake system of vehicles. The engine oil and hydraulic fluid are petroleum base fluids and are known to be incompatible with EP, SBR and natural rubber. The shock absorber fluid used in this test is a synthetic diester fluid. Its effect on elastomers is very similar to the petroleum base fluids. Experience has shown that nearly every conceivable type of contaminant can find its way into an automotive brake system. Some of these contaminants can cause catastrophic failures which are entirely independent of the type brake fluid used. A general analysis of the results of brake fluid contamination is not possible. Past efforts in the training of personnel on the proper handling of brake fluids should continue.

j. Effect on Viton rubber.

(1) Results. In this study Viton was compatible with proprietary silicone fluids, codes A and B, but was not compatible with silicone fluid, code C, and the silicone compatibility fluid. The conventional fluid caused the Viton to swell and soften excessively and was not compatible.

(2) Analysis. Viton rubber is used in O rings, valves, and diaphragms in fuel systems and does not come into contact with brake fluids. The fact that the Viton is compatible with some of the silicone fluids is worthy of note, and this information may be useful to design engineers in future developmental work in the automotive field.

2.3 (Cont'd)

k. Effect on silicone rubber.

(1) Results. The silicone rubber was not compatible with the silicone brake fluid. Excessive swelling, softening, and disintegration occurred. The conventional brake fluid is compatible with silicone rubber; only slight swelling or shrinkage occurred in all tests involving conventional fluids.

(2) Analysis. Silicone rubber is used in 0 rings and in some hoses found in the automotive systems, such as radiator hoses. Since it is chemically similar to the silicone brake fluids, the "solution effect" renders the fluid and rubber incompatible. The conventional polyglycol fluid has no adverse effect on the silicone rubber, and the rubber can be used in many applications where it is exposed to polar fluids.

APPENDIX A - TABLES

TABLE A-1. TESTS AT AMBIENT TEMPERATURE

Conditions[a]	Time	EPDM (MH69) b	EPDM (MH69) c	EPDM (70 Duro) b	EPDM (70 Duro) c	EDPM (80 Duro) b	EDPM (80 Duro) c	Natural Rubber (60 Duro) b	Natural Rubber (60 Duro) c	SBR (50 Duro) b	SBR (50 Duro) c	SBR (63 Duro) (SAE) b	SBR (63 Duro) (SAE) c	SBR (70 Duro) b	SBR (70 Duro) c
Silicone Base Compatibility Fluid (MH70)	Sample 1														
	1 week	-3	11.6	-3	7.64	-1	4.26	-2	13.2	-5	13.5	-8	15.9	-4	15.0
	3 weeks	-4	12.1	-2	7.54	-3	4.57	-6	13.4	-7	17.6	-9	17.0	-9	15.0
	7 weeks	-4	11.8	-2	6.91	-5	5.97	-7	14.0	-6	19.2	-8	17.1	-9	16.1
	6 months	-4	11.5	-2	7.49	-2	4.13	-3	13.3	-5	15.3	-7	18.5	-8	15.2
	1 year	-3	12.9	+1	7.50	±0	4.40	-4	14.3	-5	13.8	-8	18.2	-7	15.6
	Sample 2														
	1 week	-3	4.82	-3	16.0	-1	6.27	-2	11.4	-5	16.8	-8	17.0	-4	13.8
	3 weeks	-4	4.36	-2	15.5	-3	6.01	-6	10.8	-7	18.2	-9	18.4	-9	15.3
	7 weeks	-4	4.53	-2	12.5	-5	7.41	-7	11.3	-6	19.7	-8	18.3	-9	16.2
	6 months	-4	4.34	-2	15.9	-2	8.78	-3	12.1	-5	17.3	-7	18.5	-8	14.2
	1 year	-2	5.46	+1	15.5	-1	7.13	-4	11.6	-4	16.2	-9	19.5	-5	13.6
Conventional Compatibility Fluid (MH66-06)	Sample 1														
	1 week	-5	0.721	-2	0.052	-1	-0.957	-5	2.24	-4	2.87	-6	2.97	-4	3.32
	3 weeks	-4	0.973	-1	- 0.016	-2	-0.205	-4	1.78	-3	0.527	-3	0.355	-5	1.25
	7 weeks	±0	0.537	+2	0.194	+1	0.106	-2	1.52	-1	1.66	±0	2.04	-1	2.39
	6 months	-3	- 0.18	+2	- 0.74	±0	-1.46	±0	0.322	-3	- 0.289	-1	- 0.182	+1	- 0.335
	1 year	±0	0.045	+3	1.80	+1	2.65	-2	2.76	-1	1.96	+3	- 0.605	+5	- 0.469
	Sample 2														
	1 week	-5	1.28	-2	- 0.423	-1	-0.854	-5	1.67	-4	3.11	-6	8.39	-4	3.05
	3 weeks	-4	0.44	-1	- 3.81	-2	-1.27	-4	1.06	-3	1.14	-3	5.75	-5	0.811
	7 weeks	±0	1.08	+2	0.68	+1	1.02	-2	0.948	-1	2.17	±0	7.15	-1	1.98
	6 months	-3	6.95	+2	- 0.41	±0	-0.52	±0	- 0.152	-3	- 0.239	-1	5.49	+1	- 1.27
	1 year	±0	0.53	+2	[illegible]	+4	3.41	-1	2.29	-2	2.33	-1	1.98	+3	- 0.962
Silicone Base Fluid Code A	Sample 1														
	1 week	-4	6.52	-3	6.81	-3	5.81	-2	28.9	-5	11.5	-7	8.59	-4	9.97
	3 weeks	-4	7.18	-3	7.72	-5	6.81	-3	14.1	-7	4.02	-7	12.7	-6	10.8
	7 weeks	-5	8.02	-2	8.03	-4	7.23	+2	8.04	-8	5.89	-7	14.1	-7	15.3
	6 months	-3	7.92	±0	7.40	-3	7.47	+4	17.3	-3	5.51	-5	14.3	-5	13.1
	1 year	-1	3.52	±0	6.34	-2	4.89	+4	15.6	-5	3.34	-7	9.91	-5	9.11
	Sample 2														
	1 week	-4	6.61	-3	6.25	-3	4.35	-2	30.5	-5	11.7	-7	12.6	-4	10.6
	3 weeks	-4	7.91	-3	7.06	-5	5.79	-3	15.5	-7	13.3	-7	14.1	-6	13.1
	7 weeks	-5	8.36	-2	7.17	-4	6.70	+2	13.3	-8	14.4	-7	15.3	-7	15.1
	6 months	-3	7.74	±0	7.21	-3	6.56	+4	13.8	-3	11.7	-5	14.7	-5	15.7
	1 year	-2	4.51	+1	5.34	-1	4.04	+5	12.2	-5	12.3	-5	9.37	-4	9.34

Conditions[a]	Time	Viton (70 Duro) b	Viton (70 Duro) c	Neoprene b	Neoprene c	Butyl (60 Duro) b	Butyl (60 Duro) c	Buna N (60 Duro) 33% ACN b	Buna N (60 Duro) 33% ACN c	Buna N (70 Duro) 21% ACN b	Buna N (70 Duro) 21% ACN c	Buna N (70 Duro) 41% ACN b	Buna N (70 Duro) 41% ACN c	Silicone (60 Duro) b	Silicone (60 Duro) c
Silicone Base Compatibility Fluid (MH70)	Sample 1														
	1 week	- 5	30.7	-3	18.9	-1	2.30	-3	13.5	-6	12.9	-3	6.15	-10	41.1
	3 weeks	- 9	41.7	-4	21.5	+1	1.32	-6	7.96	-9	15.7	-4	4.85	-11	61.2
	7 weeks	- 9	43.7	-4	22.7	+1	1.14	-6	9.47	-9	16.2	-5	5.77	-14	68.7
	6 months	- 8	46.6	-3	21.5	+1	1.88	-4	18.3	-9	21.3	-3	11.5	-12	43.1
	1 year	- 9	47.5	-3	21.9	+1	3.14	-4	18.1	-8	16.5	-3	10.7	-15	44.8
	Sample 2														
	1 week	- 5	30.9	-3	9.07	-1	2.68	-3	16.3	-6	14.7	-3	3.63	-10	45.2
	3 weeks	- 9	39.0	-4	10.7	+1	6.02	-6	18.7	-9	16.5	-4	- 1.36	-11	57.6
	7 weeks	- 9	43.3	-4	14.4	+1	5.55	-6	18.8	-9	16.9	-5	2.39	-14	62.0
	6 months	- 8	44.0	-3	13.1	+1	2.21	-4	20.5	-9	23.3	-3	- 0.010	-12	46.9
	1 year	- 9	44.4	-3	13.3	+4	3.38	-5	20.5	-8	17.1	-2	0.815	-16	40.2
Conventional Compatibility Fluid (MH66-06)	Sample 1														
	1 week	- 6	125.0	-6	12.4	-2	-0.228	-8	44.1	-8	20.7	-9	39.2	- 3	- 1.54
	3 weeks	-27	139.0	-7	22.7	-3	-2.68	-9	42.1	-8	15.0	-9	34.5	± 0	0.462
	7 weeks	-37	213.0	-5	6.65	+1	1.00	-6	35.5	-5	9.24	-7	32.3	+ 3	2.20
	6 months	-35	238.0	±0	5.30	+3	-1.56	-6	26.2	-3	2.32	-5	49.0	+ 3	1.48
	1 year	-47	139.0	±4	11.5	+2	2.02	-4	19.1	+4	- 5.27	-4	15.1	+ 5	1.56
	Sample 2														
	1 week	- 6	125.0	-6	6.40	-2	-0.161	-8	43.7	-8	21.9	-9	38.5	- 3	- 0.700
	3 weeks	-27	137.0	-7	8.65	-3	-2.38	-9	40.9	-8	16.1	-9	34.6	± 0	3.10
	7 weeks	-27	223.0	-5	6.42	+1	-0.589	-6	34.8	-5	10.4	-7	31.5	+ 3	- 5.13
	6 months	-35	243.0	±0	4.50	+3	-1.50	-6	25.7	-3	2.98	-5	22.3	+ 3	- 2.38
	1 year	-47	1[illegible]4.0	±4	4.37	+2	2.19	-5	18.3	+3	- 4.27	-4	13.8	+ 5	- 2.22
Silicone Base Fluid Code A	Sample 1														
	1 week	- 2	5.39	-1	3.99	-1	2.58	-2	4.29	-6	4.77	-2	2.78	-11	52.2
	3 weeks	- 2	7.34	-1	4.52	-2	2.01	-2	2.55	-6	4.99	-2	0.831	-11	58.2
	7 weeks	- 1	8.56	-2	5.62	+1	2.46	-9	3.02	-7	5.52	-1	1.33	-12	61.2
	6 months	- 2	11.8	+1	4.40	+1	2.04	-4	4.05	-3	3.71	+2	4.83	-11	60.9
	1 year	- 2	11.8	±0	3.84	+3	-0.14	-5	0.032	-3	1.35	+2	- 3.38	-14	58.7
	Sample 2														
	1 week	- 2	5.10	-1	3.57	-1	2.73	-2	4.09	-6	5.78	-2	3.76	-11	49.0
	3 weeks	- 2	6.72	-1	4.07	-2	4.81	-2	2.32	-6	5.82	-2	1.58	-11	61.9
	7 weeks	- 1	8.42	-2	5.39	+1	2.12	-9	7.34	-7	6.60	-1	2.26	-12	63.1
	6 months	- 2	11.3	+1	6.08	+1	1.74	-4	10.6	-3	3.81	+2	1.66	-11	63.2
	1 year	- 2	10.9	±0	2.30	+3	0.633	-5	3.78	-3	2.42	+2	- 2.17	-14	59.5

See footnotes at end of table.

TABLE A-1 (CONT'D)

Conditions[a]	Time	EPDM (NH69)		EPDM (70 Duro)		EDPM (80 Duro)		Natural Rubber (60 Duro)		SBR (50 Duro)		SBR (63 Duro) (SAE)		SBR (70 Duro)		Viton (70 Duro)		Neoprene		Butyl (60 Duro)		Buna N (60 Duro) 33% ACN		Buna N (70 Duro) 21% ACN		Buna N (70 Duro) 41% ACN		Silicone (60 Duro)	
		b	c	b	c	b	c	b	c	b	c	b	c	b	c	b	c	b	c	b	c	b	c	b	c	b	c	b	c
Silicone Base Fluid Code B	Sample 1																												
	1 week	-5	4.97	-4	3.36	-4	3.79	-8	7.22	-5	10.6	-6	10.7	-5	9.65	-2	4.30	-2	2.43	-5	5.69	-4	4.41	-8	4.16	-4	2.40	-10	60.9
	3 weeks	-4	6.15	-3	4.67	-4	4.95	-4	9.75	+5	5.44	-7	12.3	-7	11.1	-3	7.12	-2	3.61	-9	3.35	-3	7.72	-9	6.57	-1	3.68	-7	62.8
	7 weeks	-4	8.27	-4	7.59	-4	6.15	-3	12.8	-6	18.2	-7	16.1	-7	14.5	-2	13.4	-3	7.25	+1	2.65	-3	12.5	-7	9.46	-2	5.98	-11	67.0
	6 months	-2	5.56	±0	4.50	-1	4.73	-3	6.00	-4	13.2	-5	13.3	-6	12.3	-2	15.6	+1	7.00	+3	0.20	-1	11.5	-3	7.15	+2	4.81	-11	63.1
	1 year	-2	7.52	-1	6.38	-1	6.87	-5	12.4	-7	14.6	-6	15.5	-5	13.8	-4	19.0	±0	7.81	+1	2.68	-3	12.3	-5	8.49	±0	6.44	-14	66.2
	Sample 2																												
	1 week	-5	3.27	-4	3.54	-4	5.35	-8	9.69	-5	9.01	-6	8.05	-5	8.66	-2	5.05	-2	3.33	-5	1.16	-4	4.62	-8	4.86	-4	1.49	-10	55.5
	3 weeks	-4	5.04	-3	1.58	-4	5.59	-4	10.7	+5	7.96	-7	12.2	-7	12.0	-3	3.94	-2	4.61	-9	1.60	-3	6.36	-9	6.94	-1	2.79	-7	62.6
	7 weeks	-4	7.85	-4	8.28	-4	7.35	-3	13.7	-6	16.1	-7	15.9	-7	15.1	-2	13.9	-3	7.89	+1	3.69	-3	12.3	-7	10.9	-2	4.75	-11	68.8
	6 months	-2	4.70	±0	4.98	-1	5.25	-3	10.7	-4	12.2	-5	12.6	-6	14.1	-2	17.5	+1	8.52	+3	1.00	-1	11.5	-3	7.34	+2	3.40	-11	63.4
	1 year	-2	6.85	-1	6.75	-1	7.65	-3	12.6	-5	14.2	-6	14.7	-5	14.4	-2	19.1	±0	8.41	+1	3.62	-3	11.1	-4	8.41	-2	6.21	-14	66.1
Silicone Base Fluid Code C	Sample 1																												
	1 week	-1	6.31	-1	19.4	-2	7.88	-3	11.4	-4	16.8	-8	11.4	-6	17.4	-9	43.5	-4	15.9	-2	2.84	-4	23.7	-6	15.5	-1	7.10	-10	50.3
	3 weeks	-4	6.18	-1	4.62	-2	8.21	+1	11.8	-7	17.0	-8	10.8	-7	17.9	-9	39.4	-7	18.0	-2	2.77	-8	28.4	-8	16.2	-3	9.85	-11	48.4
	7 weeks	-4	6.14	-1	4.59	-2	8.94	+1	12.6	-8	19.5	-9	11.6	-7	18.1	-10	40.3	-9	18.1	-3	2.51	-10	32.2	-9	17.0	-4	9.91	-13	49.6
	6 months	-1	4.59	±0	16.7	-1	5.52	-3	8.00	-3	11.8	-4	9.03	-5	15.9	-7	36.5	-2	19.3	-1	2.39	-4	30.0	-5	13.8	±0	9.69	-10	47.2
	1 year	±0	3.48	+1	17.3	+1	6.26	-3	8.70	-3	10.3	-3	6.70	-4	11.1	-5	26.5	-5	15.4	+1	3.21	-4	20.1	-5	9.32	-1	4.24	-14	41.2
	Sample 2																												
	1 week	-1	6.93	-1	5.28	-2	6.87	-3	7.37	-4	11.4	-1	12.3	-6	15.5	-9	43.0	-4	14.2	-2	3.03	-4	23.9	-6	14.4	-1	5.62	-10	36.0
	3 weeks	-4	7.02	-1	4.72	-2	6.89	+1	12.2	-7	18.1	-8	11.7	-7	16.7	-9	39.3	-7	18.2	-2	2.84	-8	27.1	-8	15.2	-3	8.66	-11	48.1
	7 weeks	-4	7.08	-1	4.58	-2	7.41	+1	12.7	-8	19.5	-9	11.8	-7	17.9	-10	39.4	-9	19.0	-3	2.65	-10	29.5	-9	16.8	-4	9.42	-13	49.5
	6 months	-1	4.96	±0	2.95	-1	3.33	-3	8.10	-3	11.7	-4	9.51	-5	15.2	-7	29.2	-2	18.4	-1	2.27	-4	28.5	-5	13.1	±0	8.78	-10	47.0
	1 year	-1	3.86	+1	3.67	±0	5.08	-2	8.53	-4	10.7	-4	7.23	-4	9.97	-5	26.8	-3	14.8	+1	3.21	-5	19.2	-6	9.09	±0	3.73	-14	41.8

[a]Test No. 1 ambient temperature.
[b]Change in hardness (points).
[c]Change in volume (percent).

TABLE A-2. TESTS AT 70° C (158° F)

Conditions[a]	Time	EPDM (RM69) b	EPDM (RM69) c	EPDM (70 Duro) b	EPDM (70 Duro) c	EDPM (80 Duro) b	EDPM (80 Duro) c	Natural Rubber (60 Duro) b	Natural Rubber (60 Duro) c	SBR (50 Duro) b	SBR (50 Duro) c	SBR (63 Duro) (SAE) b	SBR (63 Duro) (SAE) c	SBR (70 Duro) b	SBR (70 Duro) c	Viton (70 Duro) b	Viton (70 Duro) c
Silicone Base Compatibility Fluid (RM 70)	Sample 1																
	72 hours	-4	6.30	-4	5.14	-4	5.47	-4	9.95	-8	10.9	-10	9.41	-5	9.55	-6	12.5
	1 week	-2	5.86	-3	4.57	-4	5.36	-5	9.77	-6	11.1	-10	10.6	-7	9.84	-8	16.4
	Sample 2																
	72 hours	-4	6.55	-4	5.13	-4	5.48	-4	9.05	-8	10.5	-10	10.9	-5	9.48	-6	14.3
	1 week	-2	5.88	-3	4.80	-4	5.45	-5	9.27	-6	10.4	-10	10.9	-7	9.88	-8	18.7
												White sediment					
Conventional Compatibility Fluid (RM 66 06)	Sample 1																
	72 hours	-2	0.784	-1	0.58	-1	1.73	-1	1.35	-6	3.98	-5	4.04	-4	4.24	-12	65.5
	1 week	-2	0.589	±0	0.591	-1	4.99	-4	1.62	-3	6.24	-6	4.50	-3	1.83	-17	86.4
	Sample 2																
	72 hours	-2	1.40	-1	0.778	-1	1.95	-1	1.24	-6	3.78	-5	4.42	-4	4.31	-12	69.2
	1 week	-2	0.991	±0	0.433	-1	4.89	-4	1.77	-3	5.51	-6	7.63	-3	2.14	-17	94.8
																Swelled	
Silicone Base Fluid Code A	Sample 1																
	72 hours	-5	3.86	-4	7.68	-4	4.59	-2	9.32	-7	8.48	-7	9.78	-7	6.69	-4	4.25
	1 week	-5	6.00	-5	8.42	-4	4.49	-4	8.54	-6	9.63	-6	6.56	-5	6.56	-5	8.53
	Sample 2																
	72 hours	-5	5.22	-4	5.37	-4	4.87	-2	7.49	-7	8.53	-7	8.83	-7	8.50	-4	4.17
	1 week	-5	5.88	-5	5.05	-4	4.64	-4	7.12	-6	8.49	-8	8.36	-6	8.38	-5	6.26
																Sediment	
Silicone Base Fluid Code B	Sample 1																
	72 hours	-3	5.53	-3	5.15	-4	4.93	-4	7.12	-5	7.33	-8	7.55	-5	6.58	-3	3.99
	1 week	-2	5.68	-2	5.60	-3	6.14	-3	7.69	-4	8.06	-6	8.58	-5	8.33	-3	6.34
	Sample 2																
	72 hours	-3	5.69	-3	4.63	-4	5.01	-4	7.12	-5	7.84	-8	8.12	-5	6.99	-3	5.47
	1 week	-2	5.72	-2	5.54	-3	5.54	-3	7.50	-4	7.78	-6	8.37	-5	7.84	-3	7.52
								Sediment		Sediment							
Silicone Base Fluid Code C	Sample 1																
	72 hours	-5	7.44	-4	5.52	-4	6.71	-5	11.6	-7	15.6	-10	11.8	-7	10.0	-8	15.8
	1 week	-5	8.03	-4	6.08	-5	7.63	-9	12.8	-7	15.5	-9	10.9	-6	9.88	-8	19.0
	Sample 2																
	72 hours	-5	8.87	-4	5.16	-4	6.30	-5	11.3	-7	10.7	-10	11.6	-7	9.49	-8	6.24
	1 week	-5	8.01	-4	5.93	-5	6.84	-9	12.3	-7	11.4	-9	10.5	-6	9.64	-8	18.8

Conditions[a]	Time	Neoprene b	Neoprene c	Butyl (60 Duro) b	Butyl (60 Duro) c	Buna N (60 Duro) 33% ACN b	Buna N (60 Duro) 33% ACN c	Buna N (70 Duro) 21% ACN b	Buna N (70 Duro) 21% ACN c	Buna N (70 Duro) 41% ACN b	Buna N (70 Duro) 41% ACN c	Silicone (60 Duro) b	Silicone (60 Duro) c
Silicone Base Compatibility Fluid (RM 70)	Sample 1												
	72 hours	-1	2.21	-2	1.66	-2	8.16	-2	2.37	-2	1.06	-11	54.3
	1 week	-3	1.19	-1	1.30	-2	9.05	-4	2.10	±0	0.454	-11	54.7
	Sample 2												
	72 hours	-1	2.03	-2	0.988	-2	8.23	-2	1.72	-2	0.600	-11	54.7
	1 week	-3	1.77	-1	0.72	-2	9.07	-4	2.21	±0	0.471	-11	56.3
												Swelled	
Conventional Compatibility Fluid (RM 66 06)	Sample 1												
	72 hours	-7	10.5	±0	-0.056	-8	60.6	-15	37.7	-9	48.9	+8	0.482
	1 week	-7	9.50	+2	4.29	-7	65.8	-15	36.1	-11	47.5	+9	0.130
	Sample 2												
	72 hours	-7	10.1	±0	0.631	-8	61.0	-15	38.9	-9	48.9	+8	0.952
	1 week	-7	9.07	+2	4.26	-7	59.5	-15	37.3	-11	47.5	+9	0.588
						Swelled		Swelled		Swelled		Sediment	
Silicone Base Fluid Code A	Sample 1												
	72 hours	-1	-0.343	-2	0.823	-3	0.403	±0	-3.41	±0	2.63	-10	53.7
	1 week	+3	-1.58	-2	0.805	+1	-0.282	+3	-4.96	+3	4.41	-11	54.3
	Sample 2												
	72 hours	-1	-0.392	-2	0.643	-3	1.34	±0	-3.42	±0	3.34	-10	55.6
	1 week	+3	-1.58	-2	0.229	+1	0.015	+3	-3.53	+3	5.25	-11	54.3
										Sediment		Swelled	
Silicone Base Fluid Code B	Sample 1												
	72 hours	-2	0.488	±0	0.016	-2	4.58	-1	1.39	-2	1.01	-11	57.2
	1 week	±0	0.093	+2	1.28	+1	4.28	±0	1.63	-5	1.30	-12	60.3
	Sample 2												
	72 hours	-2	0.875	±0	0.355	-2	3.71	-1	2.22	-2	1.62	-11	60.3
	1 week	±0	0.481	+2	0.994	+1	4.12	±0	1.92	-5	1.85	-12	61.9
								Sediment				Swelled	
Silicone Base Fluid Code C	Sample 1												
	72 hours	-2	4.21	-1	1.14	-1	9.61	-3	4.37	±0	0.024	-10	54.6
	1 week	-2	4.24	-1	5.11	-3	10.3	-2	11.7	+1	0.01	-19	66.7
	Sample 2												
	72 hours	-2	3.17	-1	1.51	-1	9.50	-3	0.04	±0	0.72	-10	53.8
	1 week	-2	3.88	-1	5.34	-3	10.4	-2	2.02	+1	0.195	-19	67.6

[a]Test No. 2 70° C.
[b]Change in hardness (points).
[c]Change in volume (percent).

TABLE A-3. TESTS AT 120° C (248° F)

Conditions[a]	Time	EPDM (HM69) b	EPDM (HM69) c	EPDM (70 Duro) b	EPDM (70 Duro) c	EDPM (80 Duro) b	EDPM (80 Duro) c	Natural Rubber (60 Duro) b	Natural Rubber (60 Duro) c	SBR (50 Duro) b	SBR (50 Duro) c	SBR (63 Duro) (SAE) b	SBR (63 Duro) (SAE) c	SBR (70 Duro) b	SBR (70 Duro) c
Silicone Base Compatibility Fluid (HM 70)	Sample 1														
	72 Hours	-8	5.13	-5	7.15	-6	6.19	-27	9.30	-3	8.62	-3	8.35	-5	8.62
	1 Week	-8	9.09	-4	10.9	-7	18.0	-19	17.8	+1	18.4	+3	13.9	+2	19.8
	Sample 2														
	72 Hours	-8	9.32	-5	6.91	-6	6.16	-27	11.5	-3	8.23	-3	8.71	-5	9.71
	1 Week	-8	12.9	-4	11.1	-7	17.0	-19	16.4	+1	24.0	+3	15.6	+2	20.2
		Sediment						Sediment		Sediment		Brittle and Sediment		Sediment	
Conventional Compatibility Fluid (HM 66-06)	Sample 1														
	72 Hours	-5	1.15	±0	1.79	-2	1.64	-10	3.15	-6	7.13	-8	7.30	-4	7.01
	1 Week	-5	1.95	-1	2.05	±0	1.78	-9	4.07	-4	6.82	-7	7.38	-8	7.63
	Sample 2														
	72 Hours	-5	0.761	±0	2.09	-2	1.78	-10	2.66	-6	7.55	-8	7.46	-4	8.05
	1 Week	-5	1.61	-1	1.32	±0	1.97	-9	3.62	-4	7.59	-7	6.73	-8	8.04
Silicone Base Fluid Code A	Sample														
	72 Hours	-4	5.83	-3	4.81	-5	5.47	-7	6.20	-5	7.41	-9	7.32	-5	6.08
	1 Week	-7	6.45	-5	5.11	-5	5.84	-10	5.97	-6	6.41	-4	6.02	-5	4.90
	Sample 2														
	72 Hours	-4	6.19	-3	4.99	-5	5.57	-7	7.23	-5	8.74	-9	8.74	-5	7.03
	1 Week	-7	7.50	-5	4.97	-5	5.50	-10	6.65	-6	7.57	-4	7.54	-5	6.00
								Sediment							
Silicone Base Fluid Code B	Sample 1														
	72 Hours	-3	3.96	-3	7.12	-3	5.88	-9	7.59	-5	8.65	-9	7.87	-6	7.16
	1 Week	-5	5.11	-7	6.47	-6	5.40	-11	6.41	-6	5.29	-9	6.63	-6	5.21
	Sample 2														
	72 Hours	-3	7.43	-3	7.46	-3	6.48	-9	8.42	-5	9.34	-9	8.07	-6	7.30
	1 Week	-5	7.70	-7	6.35	-6	5.64	-11	7.66	-6	5.67	-9	7.84	-6	4.51
Silicone Base Fluid Code C	Sample 1														
	72 Hours	-6	7.49	-5	15.7	-6	7.23	-20	12.6	-7	12.3	-6	12.3	-8	9.55
	1 Week	-8	10.1	-6	17.1	-8	8.66	-33	14.5	-8	11.8	-15	8.53	-12	10.2
	Sample 2														
	72 Hours	-6	7.71	-5	6.88	-6	6.20	-20	12.2	-7	10.5	-6	12.0	-8	9.99
	1 Week	-8	10.5	-6	8.39	-8	7.60	-33	15.1	-8	11.6	-15	11.1	-12	11.4
								Breaking Down		Sediment				Sediment	

Conditions[a]	Time	Viton (70 Duro) b	Viton (70 Duro) c	Neoprene b	Neoprene c	Butyl (60 Duro) b	Butyl (60 Duro) c	Buna N (60 Duro) 33% ACN b	Buna N (60 Duro) 33% ACN c	Buna N (70 Duro) 21% ACN b	Buna N (70 Duro) 21% ACN c	Buna N (70 Duro) 41% ACN b	Buna N (70 Duro) 41% ACN c	Silicone (60 Duro) b	Silicone (60 Duro) c
Silicone Base Compatibility Fluid (HM 70)	Sample 1														
	72 Hours	-7	13.6	-2	2.69	-9	3.96	+10	5.87	+10	-7.05	±0	0.028	-24	71.2
	1 Week	-6	19.5	+5	17.2	-14	9.51	+14	18.8	+14	4.48	+6	12.6	-29	82.5
	Sample 2														
	72 Hours	-7	12.3	-2	4.87	-9	3.50	+10	5.65	+10	-0.492	±0	0.188	-24	69.7
	1 Week	-6	18.5	+5	14.9	-14	9.83	+14	18.9	+14	4.59	+6	12.3	-29	79.6
								Sediment		Brittle		Sediment		Swelled and Breaking Down	
Conventional Compatibility Fluid (HM 66-06)	Sample 1														
	72 Hours	-19	68.1	-12	17.0	±0	4.71	-5	82.7	-16	49.7	-17	65.0	-1	-0.500
	1 Week	-27	85.3	-13	18.1	±0	7.33	-16	105.0	-23	97.6	-18	67.3	-2	-0.159
	Sample 2														
	72 Hours	-19	63.4	-12	16.7	±0	4.71	-5	79.2	-16	38.9	-17	66.0	-1	-0.523
	1 Week	-27	85.5	-13	18.3	±0	6.90	-16	99.2	-23	76.6	-18	65.8	-2	-0.761
		Swelled and Breaking Down						Swelled and Sediment		Swelled and Very Soft		Swelled			
Silicone Base Fluid Code A	Sample														
	72 Hours	-3	4.38	±0	-1.23	±0	-0.269	+2	-0.229	+1	-2.73	+1	-4.78	-11	55.1
	1 Week	-3	5.95	+4	-3.02	-4	1.24	±0	1.24	+7	-6.41	±0	-7.00	-10	57.7
	Sample 2														
	72 Hours	-3	5.07	±0	-1.87	±0	-4.55	+2	0.517	+1	-4.18	+1	-3.43	-11	58.9
	1 Week	-3	6.14	+4	-3.33	-4	1.74	±0	-1.05	+7	-6.97	±0	-6.89	-10	60.0
		Swelled												Swelled	
Silicone Base Fluid Code B	Sample 1														
	72 Hours	-3	6.71	+1	-1.69	±0	-0.064	+1	3.84	±0	16.9	+1	-2.96	-11	63.2
	1 Week	-3	6.27	+4	-5.39	-3	0.883	±0	3.39	+5	-6.29	+1	-5.90	-15	74.5
	Sample 2														
	72 Hours	-3	5.18	+1	-1.56	±0	0.066	+1	3.44	±0	17.3	+1	-3.16	-11	62.7
	1 Week	-3	5.70	+4	-6.80	-3	0.048	±0	2.59	+5	-6.10	+1	-5.58	-15	71.3
								Sediment		Sediment				Swelled	
Silicone Base Fluid Code C	Sample 1														
	72 Hours	-7	13.2	-3	2.98	-2	4.57	-4	9.17	-4	2.42	-11	-0.134	-22	73.2
	1 Week	-9	16.6	-5	7.24	-4	11.9	-3	11.3	-4	0.994	-3	2.30		
	Sample 2														
	72 Hours	-7	10.4	-3	3.61	-2	4.28	-4	0.03	-4	2.56	-1	-5.29	-22	74.5
	1 Week	-9	14.5	-5	6.77	-4	9.51	-3	11.1	-4	0.449	-3	2.01		
								Sediment						Disintegrated after 1 Week	

[a] Test No. 3 120° C.
[b] *Change in hardness (points).*
[c] Change in volume (percent).

TABLE A-4. 50/50 MIXTURES OF SILICONE AND CONVENTIONAL FLUID AMBIENT TEMPERATURE

Conditions[a]	Time	EPDM ([illegible]069) b	EPDM ([illegible]069) c	EPDM (70 Duro) b	EPDM (70 Duro) c	EDPM (80 Duro) b	EDPM (80 Duro) c	Natural Rubber (60 Duro) b	Natural Rubber (60 Duro) c	SBR (50 Duro) b	SBR (50 Duro) c	SBR (63 Duro) (SAE) b	SBR (63 Duro) (SAE) c	SBR (70 Duro) b	SBR (70 Duro) c
	Sample 1 (TOP)														
	2 weeks	-5	1.44	-4	1.14	-3	-2.58	+4	4.05	-5	6.06	-3	5.89	-4	5.58
Silicone	2 months	-6	2.82	-5	3.09	-5	2.79	-6	5.84	-6	4.12	-5	7.12	-4	4.03
Base	6 months	-3	2.33	-4	1.32	-4	2.94	-4	5.02	±0	2.95	-3	4.70	-2	2.99
Compatibility	Sample 2 (BOT)														
Fluid	2 weeks	-6	1.60	-3	1.12	-3	-1.71	+3	4.45	-4	5.24	-4	5.32	-4	6.35
([illegible] 70)	2 months	-6	2.98	-5	4.26	-5	3.20	-5	5.80	-8	5.71	-6	7.08	-4	6.57
	6 months	-3	2.35	-3	1.93	-3	3.07	-3	4.55	-3	3.89	-3	5.90	-2	4.40
	Sample (TOP)														
	2 weeks	±0	5.02	+1	3.07	±0	1.64	-1	10.3	-2	7.58	±0	7.66	-2	9.66
Silicone	2 months	-4	-1.66	-2	0.23	±0	-0.58	-4	7.03	-6	2.68	-3	4.01	-3	3.59
Base Fluid	6 months	±0	3.79	±0	3.38	+2	1.35	-1	9.52	-1	4.81	±0	5.51	±0	5.40
Code A	Sample 2 (BOT)														
	2 weeks	±0	2.11	+1	0.373	+2	0.915	-1	4.33	-2	5.16	±0	4.32	-2	4.84
	2 months	-4	-1.27	-3	-2.69	±0	1.58	-4	1.25	-5	3.54	-3	2.11	-5	4.28
	6 months	±0	2.13	+1	0.678	+1	3.13	±0	3.85	-1	5.46	-1	4.75	-2	6.17
	Sample (TOP)														
	2 weeks	±0	3.00	±0	1.82	+2	12.5	-2	4.02	-1	5.64	-1	-1.17	-2	6.03
Silicone	2 months	-5	-2.59	-5	-7.00	-2	9.62	-4	-1.50	-6	0.70	-3	-8.62	-7	-4.97
Base Fluid	6 months	±0	1.97	-1	2.52	+2	13.5	-1	4.53	-1	3.76	-1	-1.69	±0	10.8
Code B	Sample 2 (BOT)														
	2 weeks	±0	0.772	-2	5.26	+2	1.18	-1	4.23	-1	-3.21	-1	6.12	±0	5.78
	2 months	-5	-3.32	-5	-4.14	-2	-1.14	-3	-0.73	-5	-7.43	-3	-4.84	-7	-1.80
	6 months	±0	1.62	-1	2.62	+2	1.54	-1	4.11	+1	-5.12	±0	5.58	-1	4.18
	Sample 1 (TOP)														
	2 weeks	-1	-1.54	-4	-7.45	-3	-1.41	-3	2.70	-6	-0.432	-5	0.615	-4	2.87
Silicone	2 months	-4	2.99	-5	2.41	-5	-0.96	-6	4.74	-5	3.10	-5	4.62	-4	3.80
Base Fluid	6 months	±0	1.08	-2	1.64	±0	-2.18	-2	4.86	±0	1.18	-3	2.54	±0	0.646
Code C	Sample 2 (BOT)														
	2 weeks	-2	-0.872	-4	-9.29	-3	-3.91	-2	0.092	-5	-1.46	-4	1.04	-4	3.46
	2 months	-5	3.16	-6	3.02	-5	-0.33	-5	4.33	-7	3.83	-5	5.50	-6	13.8
	6 months	±0	1.66	-1	1.97	-1	-1.33	-1	3.42	-3	2.37	-2	3.57	-2	6.91

Conditions[a]	Time	Viton (70 Duro) b	Viton (70 Duro) c	Neoprene b	Neoprene c	Butyl (60 Duro) b	Butyl (60 Duro) c	Buna N (60 Duro) 33% ACN b	Buna N (60 Duro) 33% ACN c	Buna N (70 Duro) 21% ACN b	Buna N (70 Duro) 21% ACN c	Buna N (70 Duro) 41% ACN b	Buna N (70 Duro) 41% ACN c	Silicone (60 Duro) b	Silicone (60 Duro) c
	Sample 1 (TOP)														
	2 weeks	-19	72.7	-5	6.04	-3	-0.203	-5	30.4	-8	19.1	-6	25.6	-15	52.7
Silicone	2 months	-29	143.0	-7	6.29	-5	0.420	-7	32.6	-5	4.15	-10	34.5	-18	57.7
Base	6 months	-25	166.0	-4	1.94	+1	0.354	-4	21.3	-4	5.10	-6	24.0	-15	60.2
Compatibility	Sample 2 (BOT)														
Fluid	2 weeks	-24	187.0	-6	9.56	±0	0.818	-7	47.4	-9	18.4	-8	37.3	-10	30.2
([illegible] 70)	2 months	-39	260.0	-7	8.23	-2	0.900	-8	40.8	-9	19.1	-10	35.1	-14	49.9
	6 months	-39	261.0	-5	3.88	+1	0.222	-5	26.7	-5	9.92	-6	27.0	-14	57.3
	Sample (TOP)														
	2 weeks	-22	83.3	-3	5.76	-3	0.762	-5	32.0	-3	12.1	-2	23.5	-10	55.8
Silicone	2 months	-26	119.0	-4	-0.59	±0	-3.14	-11	28.6	-1	-1.96	-7	18.1	-14	75.7
Base Fluid	6 months	-26	128.0	±0	1.28	+5	-0.513	-4	23.3	+2	-0.226	-1	13.0	-13	62.5
Code A	Sample 2 (BOT)														
	2 weeks	-22	169.0	-2	8.16	-3	0.916	-8	47.4	-5	18.5	-3	37.6	-10	30.9
	2 months	-34	247.0	-6	5.29	+1	-1.46	-11	35.8	-8	14.8	-9	27.6	-15	49.8
	6 months	-42	251.0	-1	4.91	+3	0.185	-6	29.7	-3	9.96	-3	20.7	-13	59.4
	Sample (TOP)														
	2 weeks	-9	41.0	-3	3.75	+2	0.436	-4	26.5	-3	13.8	-3	25.0	-9	2.63
Silicone	2 months	-23	95.3	-3	-0.33	±0	-3.94	-7	21.6	-5	2.64	-5	12.0	-18	2.32
Base Fluid	6 months	-20	120.0	+2	-0.32	+3	0.246	-2	13.9	+2	1.09	-2	10.7	-12	5.78
Code B	Sample 2 (BOT)														
	2 weeks	-18	166.0	-3	7.89	+2	-1.31	-7	44.7	-5	22.8	-5	41.7	-7	-14.7
	2 months	-25	233.0	-5	6.19	±0	-8.44	-11	32.8	-7	10.8	-5	31.6	-18	-3.15
	6 months	-53	240.0	-3	3.00	+3	-1.04	-4	25.4	±0	6.05	-2	23.1	-12	2.63
	Sample 1 (TOP)														
	2 weeks	-16	45.4	-4	0.022	-2	-18.6	-12	23.3	-7	17.2	-7	21.7	-13	51.6
Silicone	2 months	-31	112.0	-4	-0.08	-4	-0.470	-13	32.8	-8	9.82	-10	31.9	-17	54.9
Base Fluid	6 months	-26	113.0	-1	-2.99	+1	-1.27	-6	23.9	+1	-0.184	-3	22.9	-13	55.0
Code C	Sample 2 (BOT)														
	2 weeks	-28	178.0	-7	5.68	-2	-6.40	-13	41.2	-7	22.4	-9	32.3	-9	30.6
	2 months	-45	265.0	-9	7.05	-3	-0.580	-15	38.9	-11	20.9	-11	19.1	-14	49.6
	6 months	-48	286.0	-3	2.00	±0	-1.44	-7	30.3	-6	10.8	-5	28.0	-13	53.7

[a] Test No. 4 ambient temperature, 50% silicone 50% convent, compatible fluid.
[b] Change in hardness (points).
[c] Change in volume (percent).

TABLE A-5. TESTS AT -18° C (0° F)

Conditions[a]	Time	EPDM (BN69)		EPDM (70 Duro)		EDPM (80 Duro)		Natural Rubber (60 Duro)		SBR (50 Duro)		SBR (63 Duro) (SAE)		SBR (70 Duro)	
		[b]	[c]	[b]	[c]	[b]	[c]	[b]	[c]	[b]	[c]	[b]	[c]	[b]	[c]
Silicone Base	Sample 1														
Compatibility	2 Weeks	-1	1.04	+1	0.662	+1	0.304	-2	4.32	- 3	5.88	-2	5.69	-1	5.46
Fluid (BN 70)	2 Months	-3	3.26	-2	6.70	±0	1.85	-5	6.62	- 9	16.6	-5	1.19	-8	14.2
	6 Months	-1	3.15	+1	0.429	+2	1.98	-4	8.18	- 9	20.3	-4	15.8	-7	18.2
	Sample 2														
	2 Weeks	-1	1.07	+1	0.698	+1	1.40	-2	1.65	- 3	5.54	-2	- 2.35	-1	5.61
	2 Months	-3	2.71	-2	0.837	±0	1.67	-5	2.24	-10	16.3	-8	4.30	-6	10.2
	6 Months	-1	2.62	±0	0.668	+2	1.57	-4	10.8	- 9	20.0	-6	8.43	-7	18.1
Conventional	Sample 1														
Compatibility	2 Weeks	+1	-0.884	+2	1.12	+2	0.988	-2	1.67	+ 2	0.88	+1	0.939	+2	2.35
Fluid (BN 66-	2 Months	-1	0.348	±0	1.33	+1	0.854	-2	1.32	- 4	2.34	-1	1.19	-1	3.57
06)	6 Months	+1	-1.44	+1	0.625	+3	0.016	-1	1.38	- 1	1.74	±0	1.36	-1	3.25
	Sample 2														
	2 Weeks	+1	1.02	+2	1.66	+2	-2.54	-2	- 0.194	+ 2	2.34	+1	0.782	+2	1.79
	2 Months	±0	0.301	-1	1.04	+2	1.10	-2	- 0.343	- 4	3.17	-1	1.27	-1	1.94
	6 Months	±0	-0.262	+1	-0.121	+3	0.201	-1	- 0.305	- 3	3.07	±0	1.46	+1	2.35
Silicone Base	Sample 1														
Fluid Code A	2 Weeks	-1	2.42	±0	1.63	±0	1.92	-3	1.22	- 2	0.688	-2	4.19	±0	6.25
	2 Months	-2	3.23	±0	2.33	±0	2.52	-5	1.91	- 7	12.4	-4	8.06	-5	12.3
	6 Months	-1	3.79	±0	2.35	+1	2.78	-3	2.38	- 4	15.6	-3	10.5	-4	15.0
	Sample 2														
	2 Weeks	-1	2.96	±0	1.72	±0	1.48	-3	4.71	- 2	5.04	-2	4.66	±0	4.96
	2 Months	-2	3.70	±0	1.66	±0	2.40	-5	5.18	- 7	12.4	-4	9.42	-4	11.0
	6 Months	-1	4.22	-1	2.24	+2	3.08	-3	6.10	- 6	15.1	-3	12.2	-4	11.7
Silicone Base	Sample 1														
Fluid Code B	2 Weeks	-2	2.88	+1	1.33	±0	2.34	-2	3.43	- 3	8.03	-1	3.38	-1	8.32
	2 Months	-4	4.13	-1	1.86	-3	2.56	-5	5.48	- 9	14.6	-3	9.28	-6	14.0
	6 Months	-2	4.41	-1	1.78	-2	3.08	-4	6.39	- 9	17.2	-3	11.9	-4	17.3
	Sample 2														
	2 Weeks	-2	3.65	+1	1.74	±0	1.04	-2	7.81	- 3	7.57	-1	4.42	-1	6.72
	2 Months	-4	4.65	±0	2.41	-3	2.36	-5	5.57	- 6	15.8	-3	10.7	-6	14.0
	6 Months	-2	4.85	±0	2.41	-2	3.15	-4	7.33	- 6	11.2	-3	13.3	-5	17.2

Conditions[a]	Time	Viton (70 Duro)		Neoprene		Butyl (60 Duro)		Buna N (60 Duro) 33% ACN		Buna N (70 Duro) 21% ACN		Buna N (70 Duro) 41% ACN		Silicone (60 Duro)	
		[b]	[c]	[b]	[c]	[b]	[c]	[b]	[c]	[b]	[c]	[b]	[c]	[b]	[c]
Silicone Base	Sample 1														
Compatibility	2 Weeks	- 1	23.6	±0	2.38	+2	-0.17	-2	4.67	- 2	11.2	+1	1.48	-14	53.6
Fluid (BN 70)	2 Months	-10	49.0	-4	2.86	-1	-0.213	-4	10.3	-10	33.9	-3	2.66	-14	57.8
	6 Months	-11	55.2	-2	3.62	±0	-1.09	-3	13.5	- 9	38.1	±0	3.36	-13	59.0
	Sample 2														
	2 Weeks	- 1	18.9	±0	1.73	+2	-0.403	-2	3.95	- 2	9.57	+1	1.31	-14	53.0
	2 Months	-11	49.7	-2	2.11	±0	-1.68	-3	10.2	-10	30.1	-2	2.05	-14	57.6
	6 Months	-11	56.7	-1	2.95	±0	-1.40	-3	13.1	- 9	35.3	±0	2.73	-13	58.2
Conventional	Sample 1														
Compatibility	2 Weeks	- 9	53.1	±0	2.06	±0	-0.271	-1	10.4	+ 1	10.4	-3	12.0	- 1	1.26
Fluid (BN 66-	2 Months	-29	237	-2	2.06	-2	-0.191	-7	25.6	- 6	17.0	-8	25.2	- 1	1.91
06)	6 Months	-29	306	+5	2.07	+2	-0.837	-8	33.6	- 6	17.0	-8	38.6	+ 2	1.39
	Sample 2														
	2 Weeks	- 9	59.0	±0	1.58	±0	-0.364	-1	10.6	+ 1	9.09	-3	11.0	- 1	0.838
	2 Months	-29	246	-3	1.28	-1	-0.303	-8	26.8	- 6	15.2	-8	24.5	- 1	0.708
	6 Months	-31	311	+4	0.942	±0	-0.992	-8	33.7	- 5	15.2	-8	36.7	+ 2	0.228
Silicone Base	Sample 1														
Fluid Code A	2 Weeks	± 0	7.36	±0	1.54	+2	0.663	+2	5.28	+ 2	2.35	+1	2.23	-12	55.6
	2 Months	- 3	10.8	-2	1.22	-2	-1.35	-2	5.04	- 3	5.93	-3	1.17	-13	59.7
	6 Months	- 1	12.5	+4	1.17	+1	0.107	+2	6.39	- 1	9.09	±0	8.59	-13	60.2
	Sample 2														
	2 Weeks	± 0	- 2.73	±0	2.19	+2	0.921	+2	1.17	+ 2	1.02	-1	1.25	-12	33.7
	2 Months	- 4	1.18	-6	1.83	-3	-0.971	±0	0.984	- 3	4.90	-2	1.68	-14	58.0
	6 Months	- 1	2.91	-2	1.91	+1	0.186	+1	1.13	- 2	7.67	±0	14.3	-13	58.6
Silicone Base	Sample 1														
Fluid Code B	2 Weeks	+ 0	11.9	+1	2.06	-1	0.884	+1	4.13	- 2	7.35	±0	14.8	-12	60.5
	2 Months	- 7	20.2	-4	3.43	-3	0.295	-3	6.76	- 7	16.0	-3	3.80	-14	66.0
	6 Months	- 1	22.8	-1	3.95	±0	-0.295	±0	6.96	- 6	21.6	±0	3.90	-13	66.4
	Sample 2														
	2 Weeks	± 0	2.30	+1	2.03	-1	0.962	-1	3.80	- 2	6.88	±0	3.55	-12	59.4
	2 Months	- 6	20.7	-2	3.15	±0	0.168	-3	6.27	- 6	15.3	-3	4.20	-14	63.4
	6 Months	- 4	25.1	-2	3.76	+2	-0.176	-1	6.43	- 6	15.3	-1	3.72	-13	64.3

See footnotes at end of table.

TABLE A-5 (CONT'D)

Conditions[a]	Time	EPDM (NN69) b	EPDM (NN69) c	EPDM (70 Duro) b	EPDM (70 Duro) c	EDPM (80 Duro) b	EDPM (80 Duro) c	Natural Rubber (60 Duro) b	Natural Rubber (60 Duro) c	SBR (50 Duro) b	SBR (50 Duro) c	SBR (63 Duro) (SAE) b	SBR (63 Duro) (SAE) c
Silicone Base Fluid Code C	Sample 1												
	2 Weeks	-2	1.20	+1	-2.32	±0	0.785	±0	1.88	- 1	5.45	±0	2.63
	2 Months	-2	2.35	±0	0.628	-2	1.04	-3	4.00	- 8	13.1	-3	6.50
	6 Months	-1	0.88	+2	-0.139	±0	0.732	±0	2.97	- 8	16.5	±0	5.85
	Sample 2												
	2 Weeks	-2	0.968	+1	-2.33	±0	0.729	±0	1.85	- 1	4.95	±0	3.53
	2 Months	-3	1.70	±0	0.978	-2	1.45	-2	2.88	- 5	12.8	-3	7.14
	6 Months	-2	0.64	+2	0.241	±0	1.43	±0	2.04	- 6	16.1	-6	6.21

Conditions[a]	Time	SBR (70 Duro) b	SBR (70 Duro) c	Viton (70 Duro) b	Viton (70 Duro) c	Neoprene b	Neoprene c	Butyl (60 Duro) b	Butyl (60 Duro) c	Buna N (60 Duro) 33% ACN b	Buna N (60 Duro) 33% ACN c	Buna N (70 Duro) 21% ACN b	Buna N (70 Duro) 21% ACN c	Buna N (70 Duro) 41% ACN b	Buna N (70 Duro) 41% ACN c	Silicone (60 Duro) b	Silicone (60 Duro) c
Silicone Base Fluid Code C	Sample 1																
	2 Weeks	-1	4.62	- 2	28.9	±0	0.043	±0	-1.15	+2	3.73	- 4	7.84	+1	1.24	-10	46.6
	2 Months	-5	10.8	-10	58.4	-4	2.20	-2	0.093	-2	5.35	-12	34.3	-2	3.47	-11	51.5
	6 Months	-4	11.6	-10	54.1	-2	1.20	+1	-0.201	±0	5.68	-12	41.3	+1	2.21	-13	51.8
	Sample 2																
	2 Weeks	-1	4.75	- 2	30.4	±0	0.192	±0	-1.33	+2	4.20	- 4	13.0	+1	2.18	-10	46.4
	2 Months	-6	10.3	-10	62.1	-4	2.22	-3	0.143	-2	5.05	-12	33.3	-1	2.33	-11	51.3
	6 Months	-4	10.9	-11	57.8	-2	2.07	±0	0.032	-1	5.45	-12	40.1	+1	1.74	-13	51.3

[a] Test No. 5 0° F.
[b] Change in hardness (points).
[c] Change in volume (percent).

TABLE A-6. CONTAMINATED FLUIDS (GRADE 10, ENGINE OIL) AMBIENT TEMPERATURE

Conditions[a]	Time	EPDM (RM69) b	EPDM (RM69) c	EPDM (70 Duro) b	EPDM (70 Duro) c	EDPM (80 Duro) b	EDPM (80 Duro) c	Natural Rubber (60 Duro) b	Natural Rubber (60 Duro) c	SBR (50 Duro) b	SBR (50 Duro) c	SBR (63 Duro) (SAE) b	SBR (63 Duro) (SAE) c	SBR (70 Duro) b	SBR (70 Duro) c
Test 6															
Silicone Base	Sample 1														
Compatibility	1 week	- 4	9.09	- 2	4.28	- 2	-0.715	- 7	3.55	- 7	8.62	- 5	8.33	- 5	8.63
Fluid (RM70)	3 weeks	- 7	8.46	- 6	5.99	-15	1.24	- 7	4.12	- 9	14.7	- 7	11.8	- 9	16.2
	7 weeks	- 5	11.2	- 3	5.84	-10	0.946	- 6	5.69	- 9	17.3	- 6	17.5	- 6	16.1
	Sample 2														
	1 week	- 5	3.45	- 2	3.63	± 0	2.36	- 7	12.4	- 9	10.5	- 5	11.5	- 5	9.06
	3 weeks	- 7	6.69	- 6	8.39	-13	4.52	- 7	14.7	- 9	22.5	- 8	15.5	- 9	14.0
	7 weeks	- 4	6.44	- 3	5.86	-10	-5.80	- 6	14.9	- 7	17.0	- 6	17.3	- 6	15.6
Conventional	Sample 1														
Compatibility	1 week	- 3	2.06	- 4	0.57	- 1	-0.655	- 2	4.17	- 2	5.66	- 3	3.33	- 2	3.36
Fluid (RM66-06)	3 weeks	- 5	6.21	- 6	8.12	- 2	2.05	- 4	5.84	- 6	6.52	- 3	4.62	- 3	6.71
	7 weeks	- 6	10.1	- 3	9.96	- 2	6.58	- 3	7.10	- 4	7.78	- 3	9.52	- 4	7.64
	Sample 2														
	1 week	- 3	1.85	- 4	3.88	± 0	2.54	- 2	3.79	- 2	5.41	- 3	3.12	- 3	4.51
	3 weeks	- 4	5.84	- 6	8.66	- 2	5.42	- 5	6.02	- 6	7.97	- 3	6.04	- 3	9.18
	7 weeks	- 6	11.7	- 4	10.2	- 2	9.43	- 2	7.10	- 2	9.61	- 3	9.50	- 4	8.36
Test 6a															
Silicone Base	Sample 1														
Compatibility	1 week	- 7	9.56	- 3	8.97	- 2	7.18	- 7	12.8	- 7	14.4	- 7	13.1	- 5	6.60
Fluid (RM70)	3 weeks	- 9	15.7	- 7	12.2	- 6	13.8	-10	22.2	- 9	17.8	-10	22.8	-10	20.7
	7 weeks	- 9	18.4	- 7	23.2	- 5	18.0	- 9	23.9	- 9	26.9	- 8	24.7	- 9	23.0
	Sample 2														
	1 week	- 6	7.54	- 3	5.41	- 2	6.46	- 6	20.5	- 7	10.1	- 6	10.0	- 5	13.3
	3 weeks	- 9	18.0	- 7	13.2	- 6	15.4	-10	27.7	- 9	20.7	-10	20.6	-10	17.5
	7 weeks	- 8	17.3	- 7	20.2	- 6	17.8	- 9	37.7	- 8	25.2	- 7	23.8	- 9	23.5
Conventional	Sample 1														
Compatibility	1 week	- 7	10.5	- 5	6.68	- 4	7.97	- 2	8.46	- 7	8.36	- 4	21.6	- 4	6.61
Fluid (RM66-06)	3 weeks	- 8	14.0	- 5	13.3	- 6	11.2	-10	24.4	- 9	15.4	- 7	29.0	- 9	17.3
	7 weeks	-11	49.3	- 7	25.5	- 9	31.2	-11	53.6	- 8	27.9	- 8	41.7	- 9	26.7
	Sample 2														
	1 week	- 8	8.61	- 5	5.67	- 4	6.49	- 2	8.31	- 7	10.5	- 3	10.1	- 4	9.03
	3 weeks	- 8	11.9	- 5	14.1	- 6	14.0	-10	29.7	- 9	17.7	- 7	18.2	- 9	17.0
	7 weeks	-11	32.0	-10	39.5	- 5	25.8	- 9	37.3	-10	30.3	- 8	27.2	- 9	23.5

Conditions[a]	Time	Viton (70 Duro) b	Viton (70 Duro) c	Neoprene b	Neoprene c	Butyl (60 Duro) b	Butyl (60 Duro) c	Buna N (60 Duro) 33% ACN b	Buna N (60 Duro) 33% ACN c	Buna N (70 Duro) 21% ACN b	Buna N (70 Duro) 21% ACN c	Buna N (70 Duro) 41% ACN b	Buna N (70 Duro) 41% ACN c	Silicone (60 Duro) b	Silicone (60 Duro) c
Test 6															
Silicone Base	Sample 1														
Compatibility	1 week	-10	18.7	- 8	5.71	- 1	-0.125	- 3	8.11	-6	12.8	- 6	2.66	-15	52.0
Fluid (RM70)	3 weeks	-12	30.2	- 9	7.99	+ 3	6.70	- 6	11.4	-6	14.2	- 7	3.36	-15	54.7
	7 weeks	-11	40.2	- 8	11.8	+10	8.34	- 4	16.8	-7	16.1	- 5	8.13	-13	56.5
	Sample 2														
	1 week	-10	20.1	- 7	7.56	- 4	-0.457	- 3	7.41	-6	10.3	- 6	3.41	-15	50.7
	3 weeks	-12	28.6	- 9	10.0	+ 8	12.0	- 6	14.5	-6	14.0	- 8	4.30	-16	54.9
	7 weeks	-10	37.4	- 9	11.8	+11	13.5	- 4	17.3	-6	21.6	- 4	6.76	-13	56.9
Conventional	Sample 1														
Compatibility	1 week	-21	124.0	- 7	6.46	± 0	1.15	- 9	42.7	-8	20.5	- 9	36.8	- 1	0.462
Fluid (RM66-06)	3 weeks	-27	174.0	-10	4.94	- 2	2.60	-11	45.3	-9	19.2	- 9	35.6	- 3	0.298
	7 weeks	-34	207.0	- 6	4.14	- 1	7.47	- 8	33.0	-5	8.71	- 7	23.1	± 0	2.16
	Sample 2														
	1 week	-23	111.0	- 5	5.59	+ 2	0.452	- 9	45.1	-8	20.1	- 8	35.5	± 0	.094
	3 weeks	-27	179.0	-10	4.94	- 2	2.20	-11	45.8	-8	18.2	- 9	33.0	- 3	3.41
	7 weeks	-34	212.0	- 6	3.77	± 0	6.13	- 8	31.1	-3	7.38	- 6	22.8	- 1	3.11
Test 6a															
Silicone Base	Sample 1														
Compatibility	1 week	- 6	12.9	- 6	8.78	+ 2	3.59	- 4	7.23	-6	12.8	- 6	4.25	-13	56.2
Fluid (RM70)	3 weeks	- 7	22.7	- 7	9.80	± 0	4.61	- 4	9.85	-7	14.4	- 8	3.73	-15	57.6
	7 weeks	- 8	32.1	-10	13.5	+ 2	5.63	- 4	15.4	-7	14.7	- 6	6.08	-13	67.3
	Sample 2														
	1 week	- 4	17.2	- 4	7.16	± 1	2.06	- 4	8.05	-6	4.40	- 6	5.33	-13	55.2
	3 weeks	- 7	24.9	- 7	9.90	± 0	1.89	- 4	11.4	-7	14.8	- 8	6.66	-15	57.1
	7 weeks	- 8	33.5	- 8	12.4	± 0	3.88	- 4	13.9	-6	14.5	- 6	6.82	-13	57.7
Conventional	Sample 1														
Compatibility	1 week	-11	128.0	- 8	7.89	- 2	2.74	-11	43.6	-6	20.3	-12	33.7	- 5	5.01
Fluid (RM66-06)	3 weeks	-27	178.0	-11	10.1	- 5	4.73	-11	48.7	-7	21.8	-14	41.2	- 5	8.89
	7 weeks	-32	227.0	- 8	8.51	- 4	23.3	- 9	38.4	-3	12.0	-11	32.5	- 2	6.45
	Sample 2														
	1 week	-21	126.0	- 8	7.29	- 2	3.36	-11	40.6	-6	22.7	-12	40.0	- 5	5.89
	3 weeks	-27	181.0	-11	9.70	- 5	4.21	-11	50.7	-7	23.4	-14	39.8	- 5	6.66
	7 weeks	-35	238.0	- 8	7.04	- 4	21.3	- 9	38.2	-5	14.3	-11	33.0	- 2	6.89

[a] Ambient temperature, test No. 6 silicone fluid with 1% 10 wt oil. Test 6a silicone fluid with 5% 10 wt oil.
[b] Change in hardness (points).
[c] Change in volume (percent).

TABLE A-7. CONTAMINATED FLUID (SHOCK ABSORBER FLUID) AMBIENT TEMPERATURE

Conditions[a]	Time	EPDM (NM69) b	EPDM (NM69) c	EPDM (70 Duro) b	EPDM (70 Duro) c	EDPM (80 Duro) b	EDPM (80 Duro) c	Natural Rubber (60 Duro) b	Natural Rubber (60 Duro) c	SBR (50 Duro) b	SBR (50 Duro) c	SBR (63 Duro) (SAG) b	SBR (63 Duro) (SAG) c	SBR (70 Duro) b	SBR (70 Duro) c
Test 7	Sample 1														
	1 week	-5	3.95	-2	6.05	-2	3.10	-4	11.1	-4	11.3	-3	9.07	-2	6.32
Silicone	3 weeks	-4	6.01	-4	6.93	-4	5.79	-7	15.3	-8	16.5	-7	14.9	-6	14.2
Base	7 weeks	-4	9.14	-6	6.58	-2	5.37	-5	15.1	-5	16.3	-5	15.8	-6	15.2
Compatibility	Sample 2														
Fluid	1 week	-5	2.44	-2	2.80	-1	2.74	-4	6.43	-4	6.18	-3	11.6	-2	9.90
(NM 70)	3 weeks	-4	0.727	-4	5.69	-4	5.75	-7	14.4	-8	16.6	-7	16.6	-6	16.3
	7 weeks	-4	2.07	-6	6.33	-2	3.93	-6	14.9	-7	17.0	-5	16.2	-7	15.0
	Sample 1														
	1 week	-2	1.85	-1	3.18	±0	3.24	-3	2.98	-3	4.12	-2	5.75	-2	5.81
Conventional	3 weeks	-5	6.69	-4	7.40	±0	3.10	-4	7.93	-4	6.54	-3	7.28	-5	8.64
Compatibility	7 weeks	-6	10.2	-3	11.2	-1	8.87	-2	10.5	-3	8.96	-2	11.9	-4	14.3
Fluid	Sample 2														
(NM 66-06)	1 week	-2	2.99	±0	1.24	±0	1.35	-3	2.29	-3	3.61	-2	11.7	-2	4.37
	3 weeks	-5	6.44	-4	5.19	±0	3.04	-4	4.96	-4	7.39	-3	7.77	-5	8.33
	7 weeks	-4	9.40	-3	9.20	±0	6.62	-3	7.56	±0	8.76	-2	9.91	-3	9.79
Test 7A															
	Sample 1														
	1 week	-4	6.81	-2	1.56	-1	1.66	-3	12.1	-4	10.8	-6	13.0	-6	14.6
Silicone	3 weeks	-8	13.1	-6	14.9	-6	11.8	-8	22.2	-9	23.6	-8	23.3	-10	25.7
Base	7 weeks	-7	7.59	-7	18.8	-5	16.5	-9	26.4	-9	30.6	-10	23.2	-6	13.6
Compatibility	Sample 2														
Fluid	1 week	-4	8.73	-2	5.93	-1	5.44	-3	13.1	-5	16.3	-5	16.3	-6	17.9
(NM 70)	3 weeks	-8	15.4	-6	14.5	-6	12.9	-8	23.4	-9	27.2	-8	27.1	-10	24.9
	7 weeks	-7	24.4	-7	18.8	-5	16.7	-9	27.3	-9	31.0	-10	37.3	-7	18.2
	Sample 1														
	1 week	-4	5.25	-6	11.4	-2	3.28	-3	8.04	-6	8.66	-3	8.37	-4	9.12
Conventional	3 weeks	-5	7.93	-8	16.1	-4	8.14	-4	13.2	-7	18.7	-5	13.6	-8	14.4
Compatibility	7 weeks	-10	27.7	-12	40.6	-8	27.1	-8	34.7	-10	29.7	-10	41.2	-10	29.1
Fluid	Sample 2														
(NM 66-06)	1 week	-4	3.72	-6	6.65	-2	3.54	-3	9.31	-6	10.9	-3	9.99	-4	10.4
	3 weeks	-5	12.0	-8	17.9	-4	11.2	-4	14.8	-7	15.4	-5	16.7	-8	17.9
	7 weeks	-10	56.4	-12	70.3	-9	21.6	-8	28.5	-10	26.6	-10	33.2	-9	23.8

Conditions[a]	Time	Viton (70 Duro) b	Viton (70 Duro) c	Neoprene b	Neoprene c	Butyl (60 Duro) b	Butyl (60 Duro) c	Buna N (60 Duro) 33% ACN b	Buna N (60 Duro) 33% ACN c	Buna N (70 Duro) 21% ACN b	Buna N (70 Duro) 21% ACN c	Buna N (70 Duro) 41% ACN b	Buna N (70 Duro) 41% ACN c	Silicone (60 Duro) b	Silicone (60 Duro) c
Test 7	Sample 1														
	1 week	-7	18.5	-5	3.14	+2	3.79	-4	7.79	-6	10.1	-3	3.32	-13	53.8
Silicone	3 weeks	-9	30.0	-10	7.80	+1	1.63	-6	13.0	-6	14.9	-4	5.58	-14	56.7
Base	7 weeks	-11	42.4	-9	10.7	-4	0.509	-4	17.0	-6	16.0	-3	8.38	-13	56.4
Compatibility	Sample 2														
Fluid	1 week	-6	23.9	-5	5.16	+2	-0.462	-4	7.09	-5	12.8	-4	4.37	-14	52.5
(NM 70)	3 weeks	-9	31.5	-10	9.42	+1	0.839	-6	14.8	-6	15.6	-4	5.46	-14	56.8
	7 weeks	-11	39.7	-8	9.09	+2	-0.423	-5	17.0	-6	16.1	-2	7.46	-13	56.0
	Sample 1														
	1 week	-22	126.0	-5	6.90	+2	0.232	-11	41.7	-8	22.4	-10	34.6	-1	1.70
Conventional	3 weeks	-26	179.0	-7	6.12	±0	1.31	-12	42.1	-9	16.7	-11	33.9	±0	1.39
Compatibility	7 weeks	-44	248.0	-4	4.52	+1	3.65	-6	28.5	-1	6.38	-8	23.7	-1	5.90
Fluid	Sample 2														
(NM 66-06)	1 week	-22	126.0	-5	5.33	+2	2.18	-12	43.8	-8	21.4	-10	40.7	+1	1.73
	3 weeks	-26	184.0	-7	5.79	±0	0.550	-12	44.2	-9	15.6	-11	36.1	±0	1.51
	7 weeks	-44	230.0	-6	4.68	+3	6.90	-5	30.3	-2	5.53	-7	25.2	-1	6.01
Test 7A															
	Sample 1														
	1 week	-8	13.5	-8	5.52	+2	1.94	-3	7.22	-5	9.50	-3	2.86	-14	53.9
Silicone	3 weeks	-9	18.8	-10	18.4	+1	2.41	-3	10.5	-6	15.6	-3	4.10	-15	57.0
Base	7 weeks	-9	29.7	-10	15.8	-4	5.34	-4	15.4	-4	13.2	-15	3.80	-14	51.5
Compatibility	Sample 2														
Fluid	1 week	-8	14.3	-8	4.72	+2	1.71	-2	6.21	-4	11.0	-3	3.73	-14	53.6
(NM 70)	3 weeks	-9	20.8	-10	11.7	+1	2.76	-3	11.5	-6	14.0	-3	4.37	-15	57.2
	7 weeks	-9	35.4	-10	21.2	-9	5.11	-4	9.76	-3	26.0	-14	3.00	-13	53.6
	Sample 1														
	1 week	-22	138	-7	8.04	-1	1.56	-12	43.4	-11	28.4	-9	35.9	-3	5.03
Conventional	3 weeks	-26	189	-10	10.7	-2	4.68	-12	48.3	-11	22.2	-10	38.6	-3	6.25
Compatibility	7 weeks	-34	228	-11	14.1	-4	21.1	-9	33.3	-6	12.8	-6	27.0	-3	10.6
Fluid	Sample 2														
(NM 66-06)	1 week	-22	133	-7	8.54	-1	3.56	-12	38.5	-11	23.4	-10	40.0	-3	4.37
	3 weeks	-26	188	-10	11.4	-2	6.02	-12	47.1	-11	25.3	-10	38.3	-3	5.72
	7 weeks	-39	225	-11	15.0	-3	17.1	-6	32.6	-6	12.3	-5	27.0	-3	10.3

[a]Ambient temperature, test No. 7 silicone fluid with 1% shockoil. Test 7A silicone fluid with 5% shockoil.
[b]Change in hardness (points).
[c]Change in volume (percent).

TABLE A-8. CONTAMINATED FLUID (HYDRAULIC FLUID) AMBIENT TEMPERATURE

Conditions[a]	Time	EPDM (RM69) b	EPDM (RM69) c	EPDM (70 Duro) b	EPDM (70 Duro) c	EDPM (80 Duro) b	EDPM (80 Duro) c	Natural Rubber (60 Duro) b	Natural Rubber (60 Duro) c	SBR (50 Duro) b	SBR (50 Duro) c	SBR (63 Duro) (SAE) b	SBR (63 Duro) (SAE) c	SBR (70 Duro) b	SBR (70 Duro) c
	Sample 1														
	1 week	-7	14.2	-8	16.2	-8	12.9	-10	9.31	-8	19.6	-7	16.3	-9	15.4
Silicone	3 weeks	-10	21.9	-8	22.4	-8	20.1	-11	20.8	-10	30.5	-7	26.0	-9	23.9
Base	2 months	-5	17.4	-6	17.2	-5	17.1	-11	14.8	-7	22.6	-6	19.2	-6	27.2
Compatibility	Sample 2														
Fluid	1 week			-8	13.6	-9	14.1	-10	20.6	-8	24.2	-6	11.5	-8	11.7
(RM 70)	3 weeks			-8	21.7	-8	15.2	-11	15.8	-9	29.6	-7	25.5	-9	23.9
	2 months	-4	16.3	-5	16.1	-5	16.1	-10	22.4	-7	23.6	-6	18.4	-6	30.7
	Sample 1														
	1 week	-14	16.4	-6	33.7	-10	39.6	-15	32.2	-11	31.6	-7	60.3	-12	20.4
Conventional	3 weeks	-10	44.8	-8	50.5	-10	40.8	-10	36.3	-10	35.3	-8	42.2	-10	34.1
Compatibility	2 months	-12	50.2	-8	57.8	-11	50.2	-12	43.1	-13	39.6	-10	50.7	-12	42.7
Fluid	Sample 2														
(RM 66-06)	1 week	-14	28.9	-7	45.5	-10	32.0	-15	28.3	-11	26.7	-7	54.8	-11	32.0
	3 weeks	-10	45.1	-6	48.1	-11	43.4	-11	34.5	-12	32.8	-10	43.3	-10	33.7
	2 months	-12	51.6	-8	56.7	-12	49.3	-12	43.5	-12	40.8	-10	50.4	-12	41.2

Conditions[a]	Time	Viton (70 Duro) b	Viton (70 Duro) c	Neoprene b	Neoprene c	Butyl (60 Duro) b	Butyl (60 Duro) c	Buna N (60 Duro) 33% ACN b	Buna N (60 Duro) 33% ACN c	Buna N (70 Duro) 21% ACN b	Buna N (70 Duro) 21% ACN c	Buna N (70 Duro) 41% ACN b	Buna N (70 Duro) 41% ACN c	Silicone (60 Duro) b	Silicone (60 Duro) c
	Sample 1														
	1 week	-4	13.4	-6	9.61	-2	3.15	-2	5.37	-5	10.9	-2	1.59	-13	57.7
Silicone	3 weeks	-7	19.6	-7	29.1	-3	8.39	-2	17.9	-7	19.8	-2	8.84	-13	68.1
Base	2 months	-6	23.3	-5	13.9	-1	7.33	-3	13.4	-4	15.4	±0	5.55	-11	55.7
Compatibility	Sample 2														
Fluid	1 week	-4	7.59	-6	7.64	-3	2.64	-2	9.26	-5	8.14	-2	3.58	-13	58.1
(RM 70)	3 weeks	-6	22.4	-7	15.4	-1	11.9	±0	33.9	-7	18.5	-2	14.8	-13	69.1
	2 months	-7	24.3	-5	10.1	-1	7.14	-2	17.2	-4	14.4	±0	7.73	-11	41.5
	Sample 1														
	1 week	-22	137.0	-13	24.4	-8	27.4	-10	19.7	-15	70.9	-6	27.2	-9	27.6
Conventional	3 weeks	-24	168.0	-10	27.3	-5	33.8	-8	49.9	-8	18.8	-5	29.3	-9	35.9
Compatibility	2 months	-26	186.0	-13	30.3	-8	44.5	-8	22.0	-5	9.09	-4	16.2	-12	43.7
Fluid	Sample 2														
(RM 66-06)	1 week	-22	125.0	-13	21.3	-7	22.3	-10	16.1	-14	41.4	-6	45.6	-9	23.4
	3 weeks	-27	171.0	-10	23.0	-8	38.0	-8	34.2	-8	21.0	-5	30.8	-10	22.5
	2 months	-25	186.0	-12	29.7	-8	50.0	-7	22.4	-4	10.9	-4	16.9	-12	30.3

[a] Test No. 8 ambient temperature 10% hydraulic fluid.
[b] Change in hardness (points).
[c] Change in volume (percent).

TABLE A-9. VARIOUS MIXTURES OF SILICONE AND CONVENTIONAL FLUID AMBIENT TEMPERATURE

Conditions[a]	Time		Neoprene b	Neoprene c	SBR (70 Duro) b	SBR (70 Duro) c	EPDM (RM69) b	EPDM (RM69) c	Natural Rubber (60 Duro) b	Natural Rubber (60 Duro) c		Neoprene b	Neoprene c	SBR (70 Duro) b	SBR (70 Duro) c	EPDM (RM69) b	EPDM (RM69) c	Natural Rubber (60 Duro) b	Natural Rubber (60 Duro) c
Silicone Base Fluid Code A	Sample 1 (top)																		
	4 weeks	5%	-10	14.1	-11	15.8	-6	6.36	-7	14.5	10%	-10	12.1	-10	13.5	-6	5.14	-7	12.1
	8 weeks	5%	- 9	15.3	-11	15.7	-6	6.82	-7	15.3	10%	- 9	14.4	-10	14.3	-7	6.10	-8	13.2
	Sample 2 (bot)																		
	4 weeks	5%	-11	16.7	-11	15.0	-6	5.86	-8	13.3	10%	-13	18.4	- 9	13.3	-6	5.34	-7	11.2
	8 weeks	5%	-10	16.6	-11	15.6	-6	6.72	-7	14.8	10%	-10	17.3	- 8	14.5	-7	8.97	-8	12.7
	Sample 1 (top)																		
	4 weeks	20%	- 9	9.74	-10	11.6	-7	3.79	-5	10.3	30%	-10	10.4	- 9	10.5	-6	4.02	-4	7.80
	8 weeks	20%	- 7	11.9	- 8	12.2	-7	4.91	-6	11.2	30%	- 7	12.0	- 8	10.9	-6	5.11	-5	8.35
	Sample 2 (bot)																		
	4 weeks	20%	-11	14.8	- 9	11.2	-6	3.84	-6	9.01	30%	-11	14.0	- 8	9.63	-6	3.77	-5	6.96
	8 weeks	20%	- 9	14.2	- 8	12.3	-6	4.91	-6	9.86	30%	- 9	12.8	- 8	10.0	-6	4.81	-3	7.61
Silicone Base Fluid Code B	Sample 1 (top)																		
	4 weeks	5%	- 9	12.2	- 9	13.5	-3	5.10	-8	13.6	10%	- 9	9.82	-10	12.2	-5	3.97	-6	9.03
	8 weeks	5%	- 8	13.7	-10	13.6	-5	5.54	-7	14.6	10%	- 8	12.4	- 9	12.6	-6	4.74	-6	10.5
	Sample 2 (bot)																		
	4 weeks	5%	-10	15.6	- 8	13.2	-5	4.99	-7	11.4	10%	-12	15.2	- 8	11.4	-6	4.38	-7	9.74
	8 weeks	5%	-10	15.5	-10	13.7	-6	5.80	-5	12.3	10%	-10	14.3	-10	12.3	-5	4.94	-5	10.8
	Sample 1 (top)																		
	4 weeks	20%	- 9	8.84	- 8	8.90	-6	3.18	-6	7.66	30%	- 8	8.75	- 7	7.63	-5	2.71	-4	6.21
	8 weeks	20%	- 8	9.79	- 8	8.95	-5	3.74	-4	8.72	30%	- 5	7.89	- 8	8.26	-5	3.24	-3	6.99
	Sample 2 (bot)																		
	4 weeks	20%	-10	15.1	- 7	9.29	-5	4.39	-5	5.99	30%	-10	12.5	- 8	8.39	-6	2.68	-3	5.53
	8 weeks	20%	-12	12.4	- 7	9.71	-4	5.37	-4	7.51	30%	- 8	10.6	- 7	8.59	-6	3.26	-3	6.01

[a]Test No. 9 ambient temperature silicone fluids with 5, 10, 20, 30% conventional fluid.
[b]Change in hardness (points).
[c]Change in volume (percent).

TABLE A-10. NEOPRENE TESTS AT 212° F

Conditions[a]	Time	Neoprene b	Neoprene c
Silicone Base Compatibility Fluid (RM70)	Sample 1		
	3 days	- 2	3.56
	7 days	- 3	9.43
	Sample 2		
	3 days	- 3	7.47
	7 days	- 3	16.1
Conventional Compatibility Fluid (RM66-06)	Sample 1		
	3 days	- 7	17.2
	7 days	-18	21.9
	Sample 2		
	3 days	- 8	16.4
	7 days	-18	21.2
Silicone Base Fluid Code A	Sample 1		
	3 days	± 0	1.79
	7 days	± 0	6.86
	Sample 2		
	3 days	± 0	4.00
	7 days	± 3	12.9
Silicone Base Fluid Code B	Sample 1		
	3 days	± 0	1.57
	7 days	± 2	5.45
	Sample 2		
	3 days	± 2	0.142
	7 days	± 6	4.67
Silicone Base Fluid Code C	Sample 1		
	3 days	- 7	4.93
	7 days	- 7	10.7
	Sample 2		
	3 days	-10	8.35
	7 days	-11	14.1

[a] Test No. 10 neoprene rubber at 212° F.
[b] Change in hardness (points).
[c] Change in volume (percent).

APPENDIX B - REFERENCES

1. Authority: TECOM Task No. 7-CO-IL8-AP1-001, Agency Accession No. DA OM 1499, ILIR Work Unit 001 K2 02.

2. MERDC Report No. 2132, Silicone Brake Fluids; One Year Field Test, February 1975 (AD A012849).

3. MERADCOM Report No. 2164, Silicone Brake Fluids, Two Year Field Test, January 1976 (AD OZ6180).

4. Military Specification, MIL-B-46176, Brake Fluid, Silicone, Automotive, All Weather, Operational and Preservative.

5. Federal Specification, VV-B-680, Brake Fluid Automotive.

6. Military Specification, MIL-H-13910, Hydraulic Fluid, Polar Type, Automotive Brake, All Weather.

7. Military Specification, MIL-P-46046 Preservative Fluid, Automotive Brake System and Components.

8. Military Specification, MIL-L-2104, Lubricating Oil, Internal Combustion Engine (Heavy Duty).

9. Military Specification, MIL-L-46167, Lubricating Oil, Internal Combustion Engine, Arctic.

10. Military Specification, MIL-H-6083, Hydraulic Fluid, Petroleum Base, for Preservation and Operation.

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